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A Modified Trap Technique for Monitoring *Reticulitermes* Subterranean Termite Populations (Isoptera: Rhinotermitidae)

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Abstract.—Previously described collection units for studying subterranean termite (Isoptera: Rhinotermitidae) field ecology are either visible above ground, disruptive to termite foraging galleries, or designed specifically to accommodate the larger foraging populations and greater wood consumption of Formosan subterranean termites. A modification of these trap designs is described that is more suitable for field experiments and long-term monitoring in urban areas of the predominant North American genus of subterranean termites, *Reticulitermes* Holmgren.

Subterranean termites in the holarctic genus *Reticulitermes* Holmgren (Isoptera: Rhinotermitidae) are serious pests of urban structures worldwide (Weesner, 1969; Edwards and Mill, 1986). In the province of Ontario, the eastern subterranean termite *Reticulitermes flavipes* (Kollar) was first reported in the late 1920's (Kirby, 1965), has now been found in 29 municipalities, and is responsible for over a million dollars annually in treatments and structural repairs (Grace, 1987). The ecology, foraging behavior, and population demographics of this genus are difficult to study in the field due to their subterranean gallery systems. Excavation (Howard et al., 1982; King and Spink, 1969), and collection of infested wood (Esenther, 1969; Haverty and Nutting, 1975; Husby, 1980) have been used to investigate subterranean termites at rural sites, but are disruptive, preclude further study at the disturbed site, and are not practical in most urban settings.

R. flavipes occurs in and near urban areas in Ontario, and study problems are compounded by the possibility of vandalism of field sites. Thus, highly visible techniques such as placing toilet paper rolls on the soil surface to monitor termite feeding (La Fage et al., 1973) are not practical. Subfreezing winter temperatures in the northern regions of *Reticulitermes* distribution also mandate that traps for seasonal monitoring extend into the soil, below the frostline.

A number of trapping techniques have been described to aggregate and collect subterranean termites. Su and Scheffrahn (1986) described an underground collection unit consisting of a wooden box within a short length of polyvinylchloride (PVC) pipe, with a plastic cap, that is buried below the soil surface at urban sites to monitor Formosan subterranean termite (*Coptotermes formosanus* Shiraki) activity. Esenther (1980) buried corrugated fiberboard "sandwiches" to collect *R. flavipes,* and La Fage et al. (1983) described a method of extracting subterranean

termites from infested wood by placing a short length of PVC pipe containing a roll of moistened corrugated fiberboard on top of the wood. French and Robinson (1985) employed a similar technique to aggregate the mound-building *C. lacteus* by extending plastic pipes containing rolled corrugated fiberboard into a termite mound and attaching a larger section of pipe to the opposite end containing a wood sample to be evaluated.

The collection trap described in this paper is a modification of the above techniques, suitable for collecting large numbers of *Reticulitermes,* long-term population monitoring, and multiple choice feeding assays in the field with different substrates.

Materials and Methods

Field sites for studying the population demographics of *R. flavipes* were established in spring 1988, at several urban locales in southern Ontario. Two of these sites are within the Municipality of Metropolitan Toronto: one in the City of Scarborough and the other in the City of Toronto. The Scarborough site is located on the bluffs overlooking Lake Ontario, and includes an unimproved park area at the edge of the bluffs with a canopy largely consisting of Manitoba (*Acer negundo* L.) and Norway maple (*A. platanoides* L.), and two residential lots separated by a gravel private drive and parking area. The Toronto site is ca. one-half of a city block of subsidized housing in the downtown area and consists of semi-detached (duplex) homes and small apartment buildings surrounded by a well-kept lawn, and bisected by a paved laneway and parking area.

In May and June, 1158 white pine (*Pinus strobus* L.) stakes, each ca. 1.5 × 4 × 15 cm, were installed at the Scarborough site, and 461 stakes were installed at the Toronto site. Each stake was sheathed in a single layer of dampened single-faced corrugated fiberboard to aggregate foraging termites. In Scarborough, stakes were placed in a 1 × 1-m grid throughout the park and garden areas and a portion of the parking area, and along fences. In Toronto, stakes were placed at 2–3-m intervals along all fences and paved areas, and around buildings, stumps and trees. Termite activity in the stakes and cardboard sheaths was monitored at 1–2-wk intervals. Where termite activity was noted, the stake was replaced by a collection trap, with adjacent traps installed no closer than 2 m.

The *Reticulitermes* collection trap resembles that described by Su and Scheffrahn (1986) for monitoring Formosan subterranean termites. Using a trenching shovel, a hole is excavated of sufficient size to accommodate a 15-cm length of 10-cm (4-in.) ID plastic (ABS) pipe, placed vertically with the rim slightly below the soil surface. Two 15-cm lengths of 4-cm (1½-in.) ID ABS pipe are then placed next to each other vertically within the larger pipe. Each of these smaller diameter pipes contains a tightly rolled sheet of moistened single-faced corrugated fiberboard (boxboard) as the termite feeding substrate. This material has been employed by Esenther (1980), French and Robinson (1985), Howard et al. (1982), La Fage et al. (1983), and other researchers (e.g., M. Hubbes and D. Trudeau, pers. comm.) to aggregate subterranean termites. The larger exterior pipe is then capped with an ABS test cap (Niagara Plastics Co.), and the cap covered with a thin layer of soil, leaves, or turf. The exterior pipe thus forms a permanent trap installation, while the interior pipes are easily removed and replaced with minimal disturbance to foraging galleries in the soil. When the interior pipes are removed,

Table 1. Number and caste proportions of *Reticulitermes flavipes* foragers in traps monitored on the same date in early August at two Metropolitan Toronto sites.

Site	Trap	Number of termites	Caste proportions (%)			
			Workers	Nymphs	Larvae	Soldiers
Scarborough	S86	3085	98.0	1.3	0.2	0.5
	S232	4220	96.7	2.4	0.6	0.3
	S242	3801	95.2	3.7	0.0	1.0
	S483	1315	97.6	1.0	0.5	0.8
	S533	3948	94.6	4.2	0.5	0.8
	S538	1125	97.4	1.1	1.1	0.4
	S574	2862	89.8	8.2	1.2	0.7
	S721	2888	98.1	1.0	0.0	0.9
	S723	2165	97.0	2.4	0.1	0.5
	S746	1154	94.6	3.5	1.0	0.9
	S772	3618	99.0	0.7	0.2	0.8
	S777	2666	98.3	0.6	0.2	0.9
	S957	4092	98.9	0.8	0.0	0.2
	S978	1998	98.9	0.7	0.1	0.4
	S1020	5025	97.5	1.7	0.4	0.4
	S1035	3884	98.2	1.2	0.0	0.6
	S1037	2930	97.8	1.2	0.2	0.7
	S1041	3077	98.6	0.7	0.1	0.6
	S1080	2180	98.6	0.3	0.6	0.5
	S1103	704	97.3	0.7	0.4	1.6
Toronto	T59	326	95.1	0.6	0.0	4.3
	T216	2206	96.6	1.0	0.4	2.1
	T218	437	98.2	1.1	0.0	0.7
	T223	2974	98.2	1.6	0.2	0.1

each end is capped with a small ABS plastic test cap, and termites are transported to the laboratory in the original collection pipe.

Results and Discussion

In June through August, 44 traps were installed at the Scarborough site, and 21 at the Toronto site. During the summer months of peak termite activity, traps were monitored at intervals of 3–10 days, and fiberboard in active traps was frequently consumed within 5 days. Data from one collection date are presented in Table 1. The maximum number of termites recovered from a single two-pipe collection unit was 7622. Over 200,000 termites were removed from the Scarborough site in soil trap units within one 15-day period.

A major advantage of this trap design is the ease with which *Reticulitermes* foragers can be removed from the field and transported without mixing collections from different traps. *R. flavipes* collected in the traps are readily transported from the field as complete foraging aggregations. A large number of the small pipes, with both ends capped, can be stacked in a box or portable cooler without any possibility of damage to the insects within them. As long as fiberboard remains in the pipes, they can be safely stored for several days in the laboratory before processing, or the insects can be frozen within the pipe for permanent preservation.

In addition to its use in mark–release–recapture studies of *Reticulitermes* foraging dynamics using dye-marked termites (Grace and Abdallay, 1989), moni-

toring population demographics, and collecting termites for laboratory investigations, this trap can be used as a multiple-choice foraging arena to expose termites simultaneously to several different feeding substrates within a single trap unit. It is also possible to autoclave the small pipes with their cellulosic contents and place a sterile substrate in the field (paired with a nonsterile pipe, if desired) in order to isolate bacteria and fungi associated with *Reticulitermes* (Zoberi and Grace, in prep.), or to examine termite-mediated changes in the composition of soil carried into the traps by foragers.

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